Line-of-Sight Compendium

(Briefing to) American Congress of Surveying and Mapping

17 April 2004

Background

- **The Line-of-Sight Technical Working Group was established on June 5, 2003 by the Topographic Engineering Center**
  - **To Understand Differences Between LOS Algorithms**
  - **To Provide Standard Reference Data and a Process for Testing LOS Applications**
  - **To Establish a Forum Where Experts in LOS Algorithms can Exchange Ideas and Research**
  - **To Produce a LOS Compendium**

Purpose of LOS Algorithms

- **Simulated LOS for Models and Simulations**
- **Position Sensors to Maximum Visibility**
- **Position Targets to Minimize Visibility**
- **Position Industry to Minimize Visibility**
- **Insure Microwave Towers are Visible to Each Other**

Basically, we need to answer the question:

Can a sensor at location A see a Target at location B?

How is the Terrain Depicted?

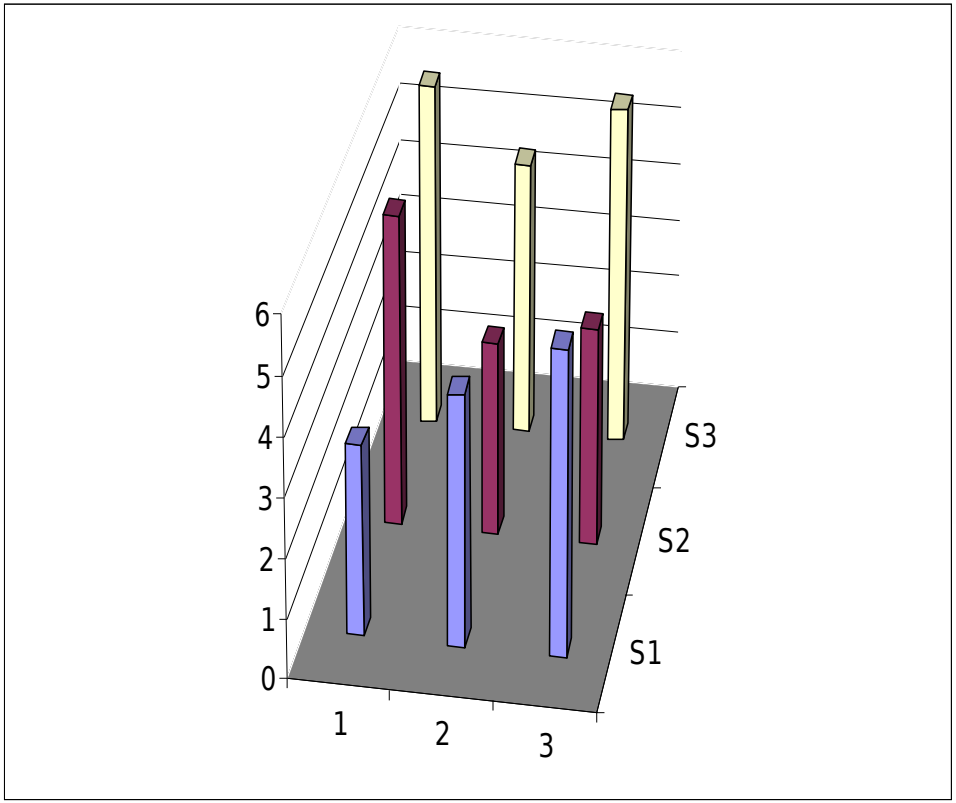
Everything Starts as a Grid

- **Grid**
- **Grid Cells**
- **TINs**
- **Splines**
- **Other Methods (i.e. contour lines)**

Each Representation can have a family of algorithms

Grid Representation of Terrain

- Each ‘post’ represents an elevation.
- Algorithms use different methodologies to fill in terrain between posts.
- Math is easy.



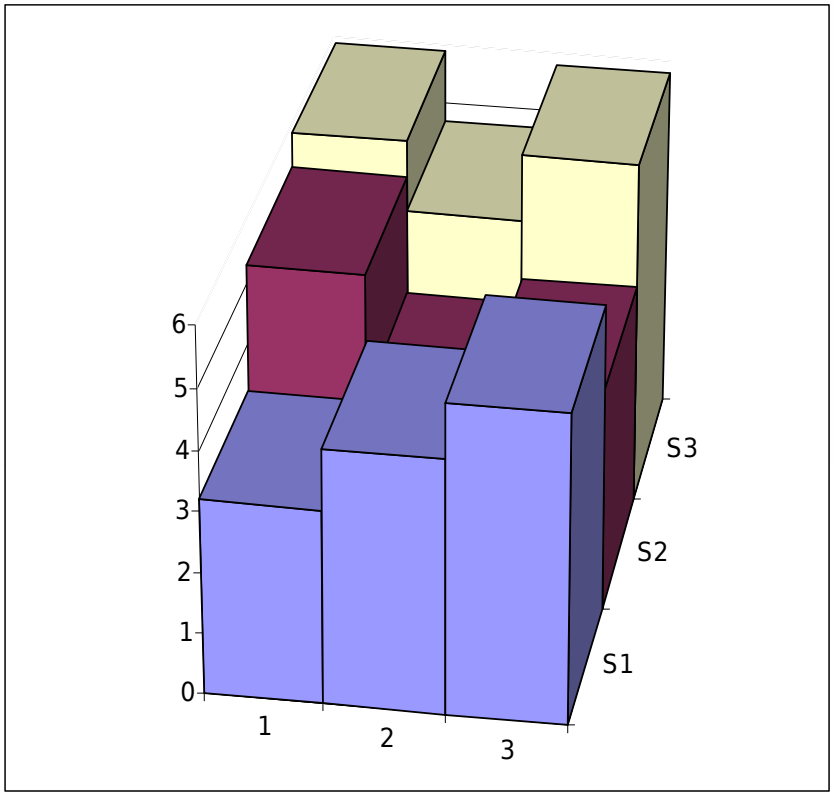
Most Common Representation

Most Accurate

Cell Terrain Representation

- **Each grid is assumed to be a plateau.**
- **Math is easy.**
- **Usually less accurate.**

Very Fast !!

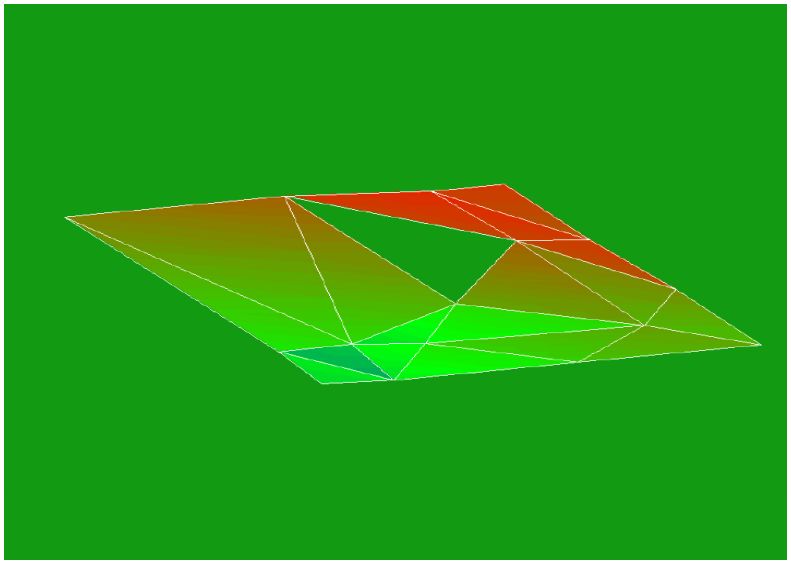


Terrain Represented as a Triangular Irregular Network

- **Complex Math**
- **Reduced Storage**
- **Variable Resolution**
- **Many Methodologies**

  to TIN Terrain (dozen's)

  with varying accuracy
- **Visual Simulators**
- **Not Differential at Edges**



As TINs are reduced,

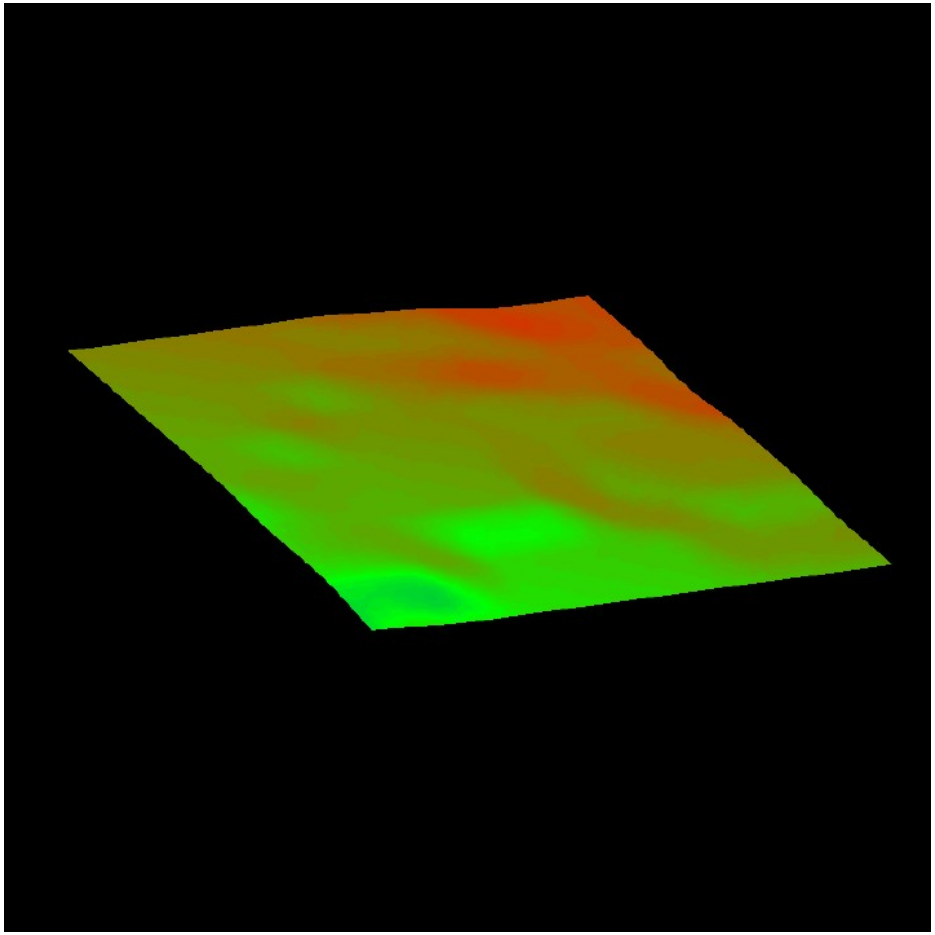
what happens to LOS?

Terrain Represented as a Spline

- **Immature**
- **LOS computed as**

  a directional

  derivative
- **Very Slow**



Ground Rules for Discussing LOS Algorithms

We will examine ‘concepts’, not proprietary

software implementation

Example: LOS in a TINned Database Using

the Exact Geometric Intersection Method

Concept: “LOS is examined at all of the intersections between the polygon edges and the sensor/target line”

Ground Rules (Continued)

Implementation 1: Put polygons into a list and examine every edge of every polygon in the database when calculating LOS.

Implementation 2: Degenerate edges of polygons into an edge file and examine intersection of edges between sensor and target for blockage

Same Answer – Different Implementations!!

LOS Compendium

- **Algorithm name**
- **Point of contact information**
- **Computer language of algorithm**
- **Target audience: (constructive models, virtual models)**
- **Coordinate systems used (UTM, Geocentric, Lat/Long)**
- **Feature (vegetation/urban) representation: (none, presented as solid objects, represented as opaque objects, use of a user defined distance of vegetation penetration).**
- **Elevation data representation: (evenly spaced grid, unevenly spaced grid, TIN, spline, wavelet)**
- **Sensor and target heights: (user selected or hardwired)**

LOS Compendium (continued)

- **Sensor and target locations: (nearest grid point, interpolated)**
- **LOS scope (flat earth, curved earth, radar LOS)**
- **LOS investigation: (Point-to-point, point-to-area, area-to-point, area-to-area, LOS along radials, LOS into a user defined polygon)**
- **Point interpolation (none, nearest point, SW corner, weighted average of surrounding points, bilinear interpolation, triangle interpolation, polynomial interpolation, spline).**
- **Other considerations**

Issues Not Covered
(in the short term)

- **Detection and acquisition.**
  - **Currently, these issues are being revisited for accuracy. Also, LOS is a geometry issue while detection is a physics issue.**
- **Refraction, reflection, obscurants.**

Included Algorithms

- **DYNTACS**
- **Bresenham**
- **Battlespace Terrain Reasoning and Awareness**
- **Perspective View NT**
- **JWARS Terrain PLOS**
- **Probability of LOS**
- **MICRODEM/TerraBase**
- **GRASS**
- **Janus**

LOS Algorithms To Be Included in the Future

- **Janus LOS Algorithm**
- **ModSAF LOS Regular Triangle Algorithm**
- **Triangulated Irregular Network (TIN) LOS Algorithm**
- **ESRI LOS Algorithm**
- **TerraBase LOS Algorithm**
- **Intergraph LOS Algorithm**
- **MapInfo LOS Algorithm**
- **Bently LOS Algorithm**
- **ERDAS LOS Algorithm**
- **AutoDesk LOS Algorithm**